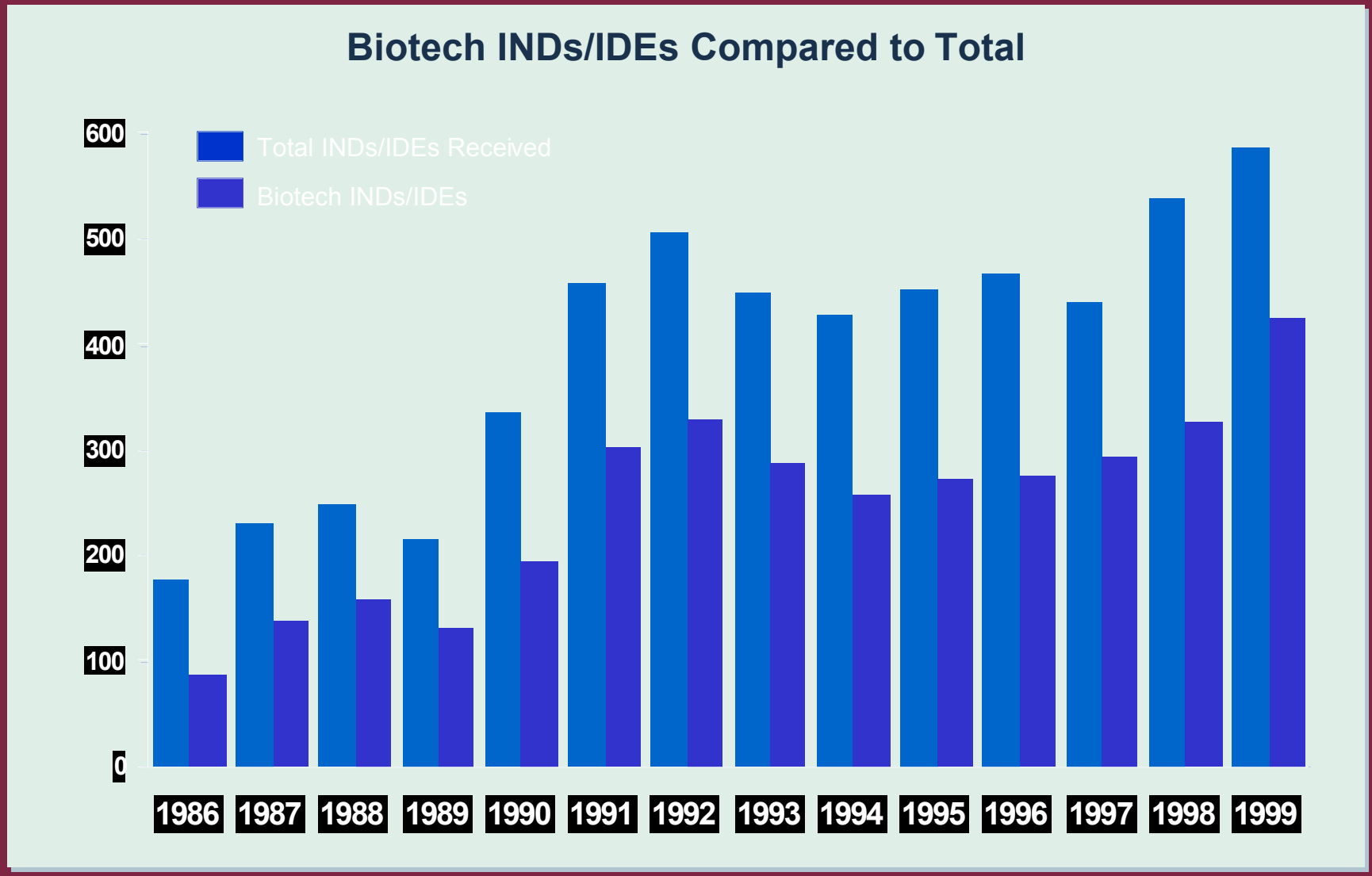
Benefits of Biotechnology

- A virtually safe blood supply
- Cure for anemia
- Reduced spread of hepatitis
- Saving lives after heart attacks
- Slowing the progression of multiple sclerosis
- Better quality of life for diabetics
- Longer life for cancer patients
- Reducing the Debilitating Effects of Rheumatoid Arthritis
- Slowing the Progression of HIV Infection
- Improved outcomes for Chronic Hepatitis C

Biotech Industry Trends *Submissions to FDA Increase*



Source: CBER; Burrill & Company.

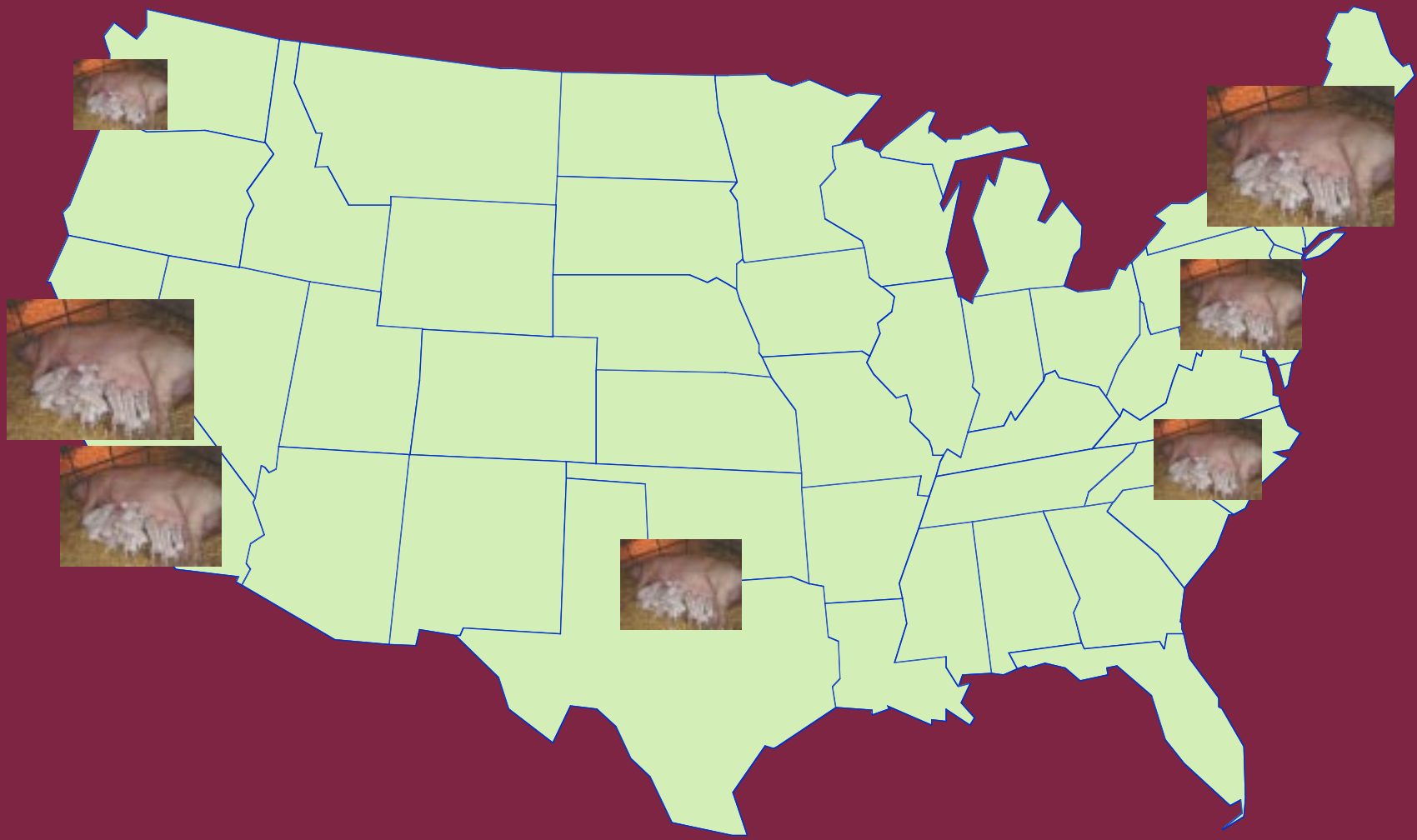
Biotechnology Reliant on Local Resources, especially Research Universities

Picture source: http://www.pigparadise.com/

Intellectual Assets, Capital, and Infrastructure Drive Biotech Clusters

- **Universities essential for biotechnology growth**
  - **Nearly one-third of Bay Area biotech companies are spin-offs from academic research institutions**
  - **Two-thirds of Bay Area biotech companies have research agreements with California academia**
  - **Universities continue to train skilled scientific personnel**

Geographical Clustering



California Has Most Developed Cluster of Biotech Companies

- **California leads the nation with greater than 33% of all biotechnology companies**
- **California biotech companies account for 45,000 highly-skilled jobs at an average salary of $65,800**
- **California universities, federal laboratories, and private institutions account employ an additional 41,000 people**
- **80% of California biotech companies plan to expand in the next two years**
- **88% of biotech companies anticipating growth intend to grow in California**

Pharmaceutical Companies Seek to Capitalize on California Biotechnology

- **Novartis founds Novartis Research Institute in San Diego**
- **Novartis takes major equity stake in Chiron**
- **Roche heavily invested in Roche Biosciences as well as Genentech**
- **Pfizer heavily invested in Agouron and Gene Networks through Parke-Davis/Warner Lambert acquisitions**
- **Merck acquires Sibia**

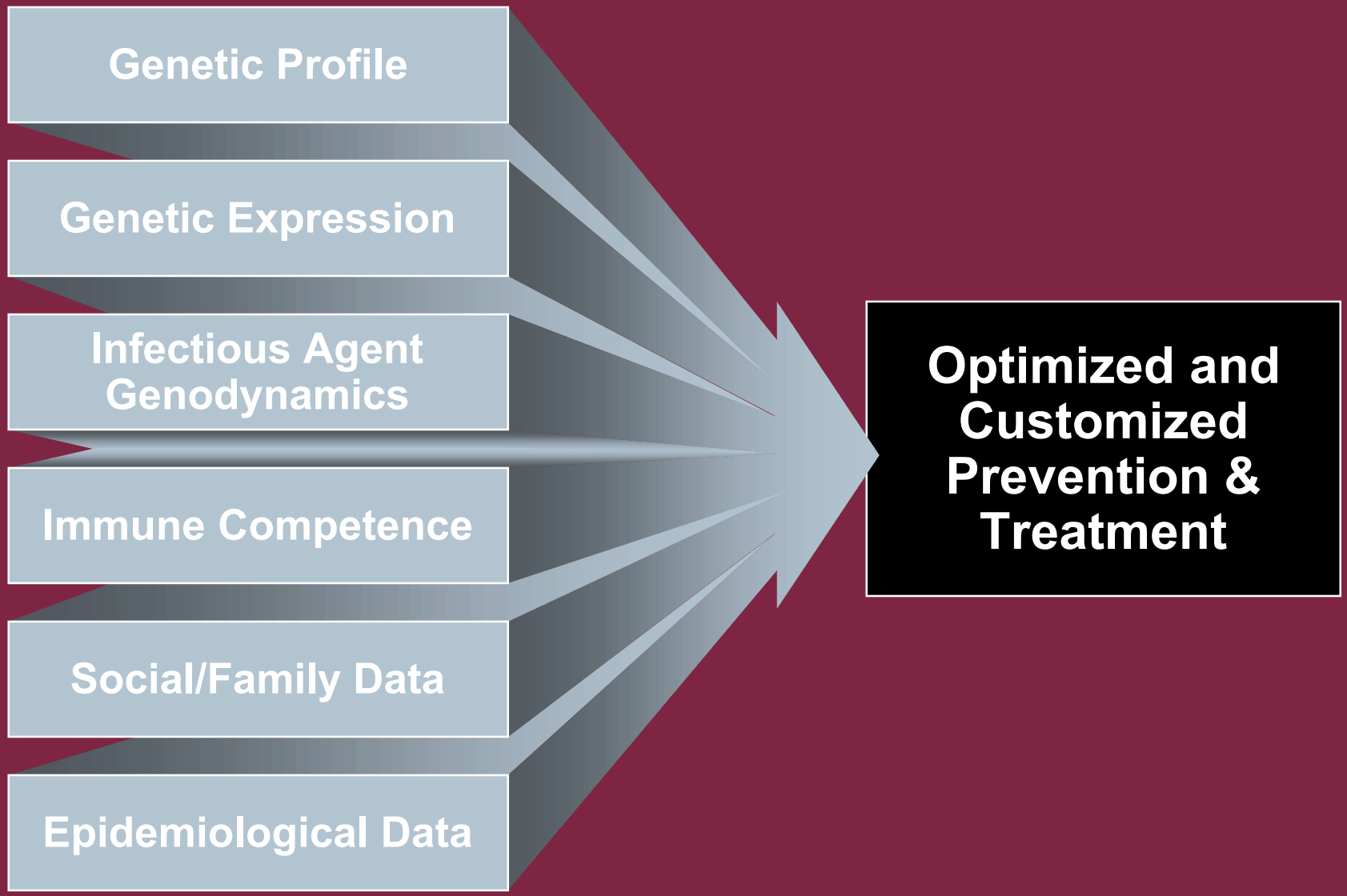
The Biotechnology Enterprise

- The Benefits of Biotechnology
- Vital Statistics/Industry Trends
- Blurring of the Borders Between Biotech and Pharma
- Geographical Clustering
- Universities Remain the Driver for Biotechnology
- Information and the Customization of Medicine
- Healthy Long-Term Outlook

Explosive Development of New Information

- **Human Genome project**
- **Genetic analysis of disease**
- **Pathological mechanisms**
- **Gene expression in normal and pathological states**
  - **New metrics**
  - **Diagnostic and therapeutic monitoring**
  - **Gene therapy**

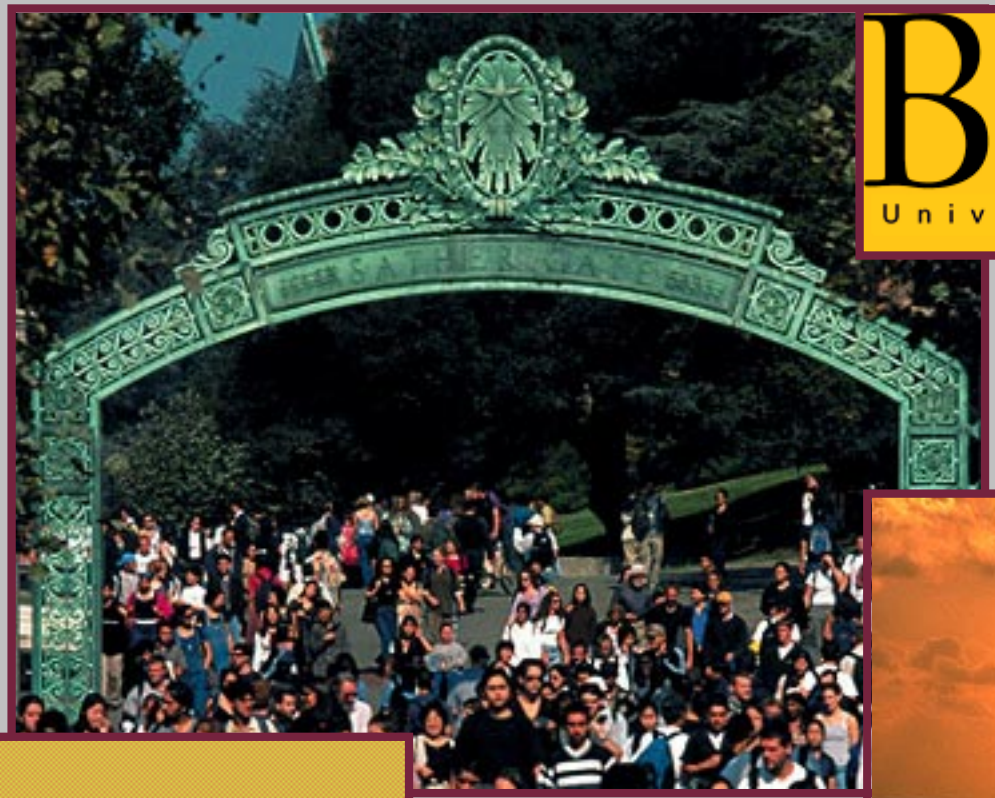
Individualized Information and Metrics Will Drive Clinical Practice



Positive Trends for Biotechnology

- Consolidation of healthcare purchasing and testing
  - Less infrastructure required for effective marketing
- Increasing awareness and activism about personal health issues
  - Concern over infectious diseases
  - Employer recognition for value in prevention
  - Premium for reduction of risk
  - Third largest use of the Internet
- High visibility in Washington
  - Expanded funding for NIH
  - New FDA guidelines for biologicals
  - Continued pressure for accelerated drug approval
- Baby boomers have both money and political clout to sustain quality of life

The Health Sciences Initiative

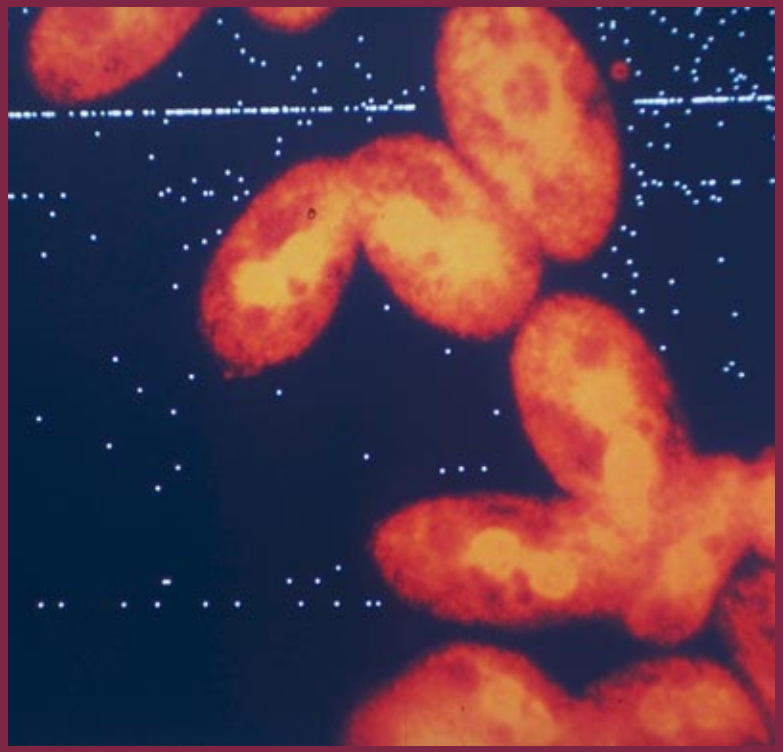


Berkeley
University of California

"If you are bored with Berkeley, you are bored with life."

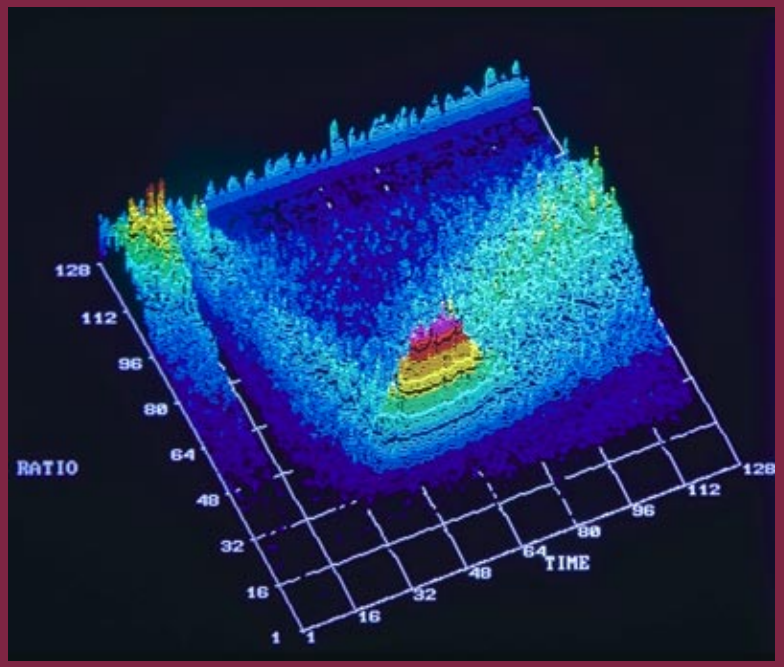
CLARK KERR
FORMER CHANCELLOR

CANCER RESEARCH: BLOCKING CANCER'S PATH



Controlling cancer growth by using drugs to block the human enzyme telomerase

CANCER RESEARCH:
THE BODY'S OWN DEFENSE



A prime goal of cancer research: Use the body's own natural defenses

- Free the immune system to fight cancer
- Use with traditional treatments
- Possible vaccine against recurrence

Cancer Research:
Unleashing the Body's Own Defenses

- Use the body's own natural defenses

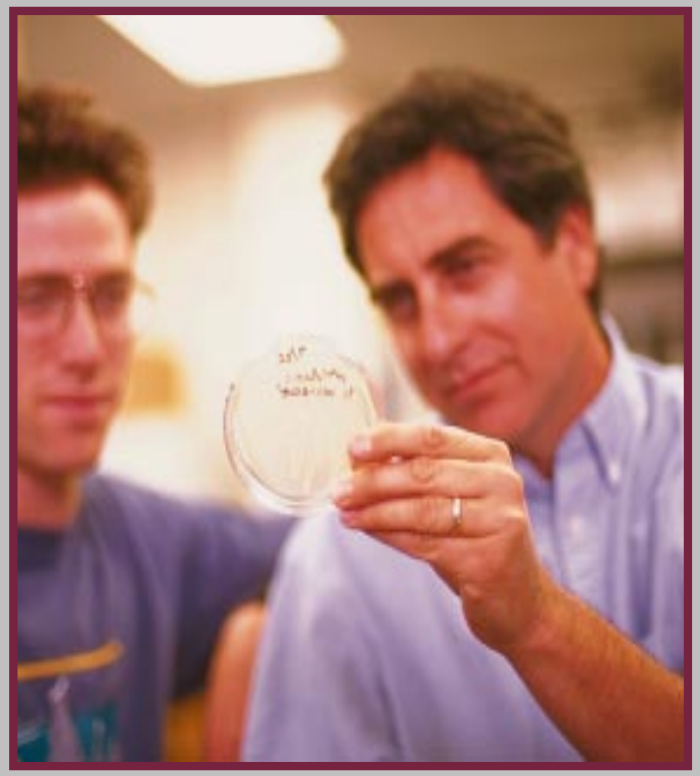
- Free the immune system to fight cancer

BUILDING BETTER DRUGS

Structural biology

- Determine how cells' motor proteins (topoisomerase) work to maintain and use DNA
- Aim to create less toxic anti-cancer drugs

Infectious Disease:
The Opportunity to Develop New Vaccines



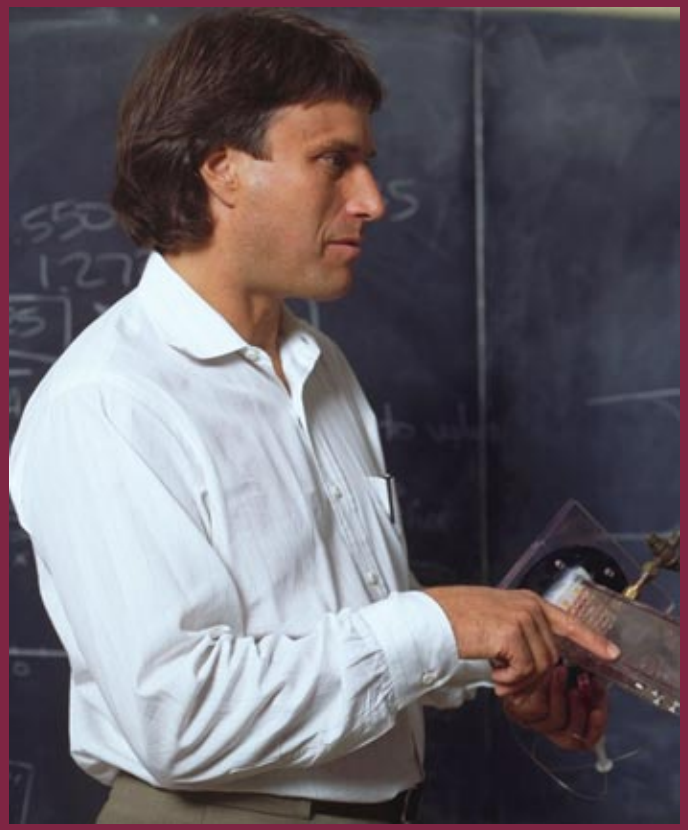
- Basic research on pathogenic bacteria leads to new ways to target vaccines

- New vaccines for cancer, AIDS, Tuberculosis, and other diseases

Epidemiology and Infectious Disease: From the Laboratory to the Field

- New diagnoses and vaccines for:
  - Leischmania
  - Dengue Fever
  - Tuberculosis

DRUG DELIVERY: NEW WAYS TO TAKE YOUR MEDICINE



MEMS
(micro-electrical-mechanical system)

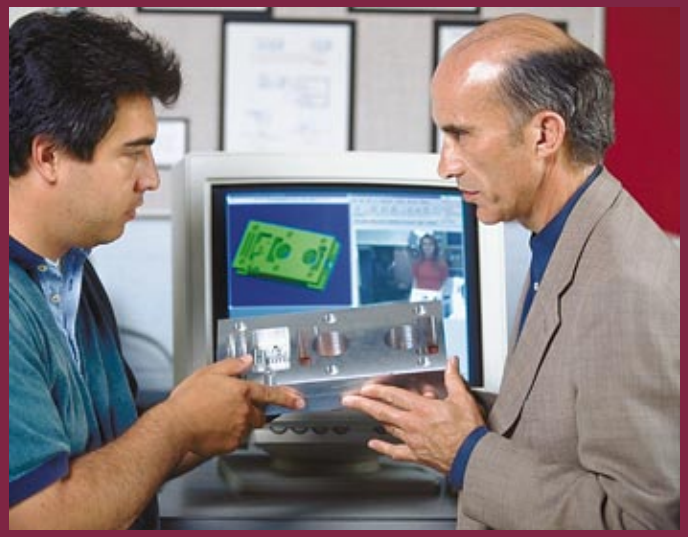
- Miniature devices
- Easier drug delivery
- Fewer side effects
- Help for patients far from hospitals
- New medicines possible

ROBOTIC SURGERY: A VIRTUAL REALITY

Minimally invasive surgery

- Using advanced imaging and tiny surgical robots
- Performed from remote location
- Cutting health costs

BERKELEY'S HEALTH SCIENCES: GLOBAL CONNECTIONS

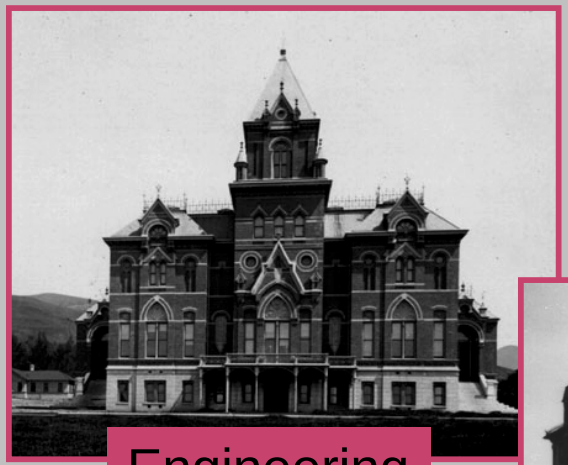


- Delivery of medical information and teaching tools to laboratories, classrooms, and clinics
- Medical information data banks for students and health care practitioners worldwide
- Hypermedia courseware, video conferencing, and other electronic tools accessible from remote locations

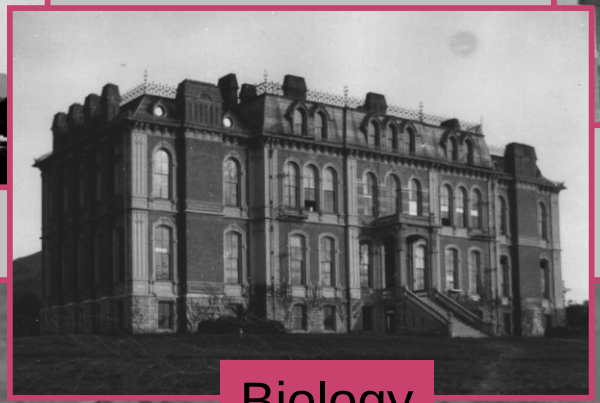
BERKELEY'S HEALTH SCIENCES: A WORLDWIDE FUTURE

With digital multimedia and informatics, the impact of Berkeley's health sciences initiative will be worldwide

The Past Approach:
Separate Scientific Disciplines

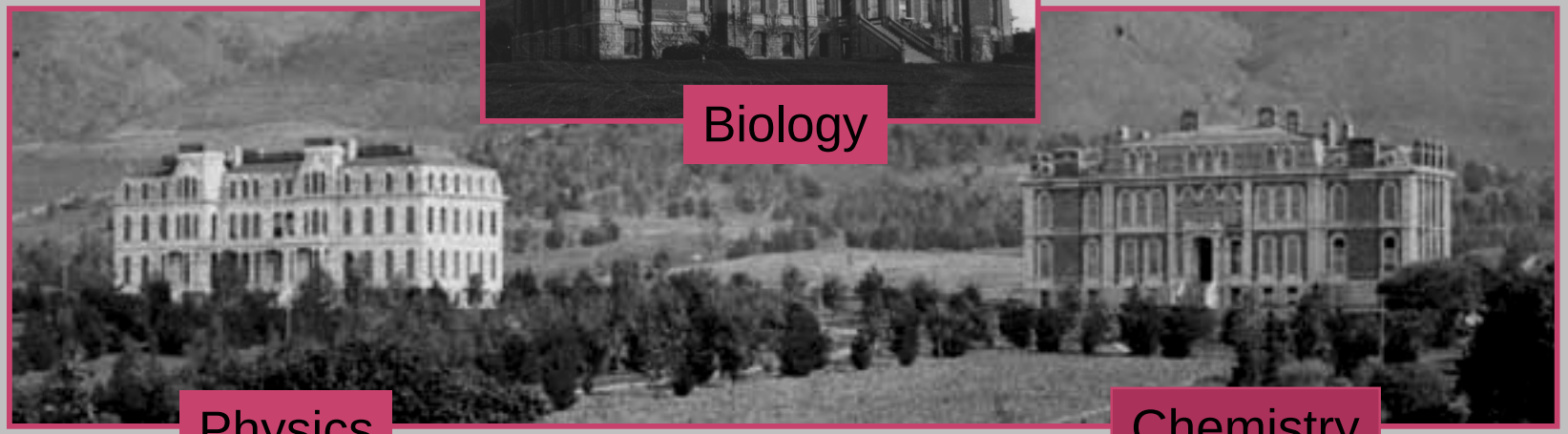


Engineering



Biology

Computer Science



Physics

Chemistry

U.C. Berkeley's National Research Council Ranking

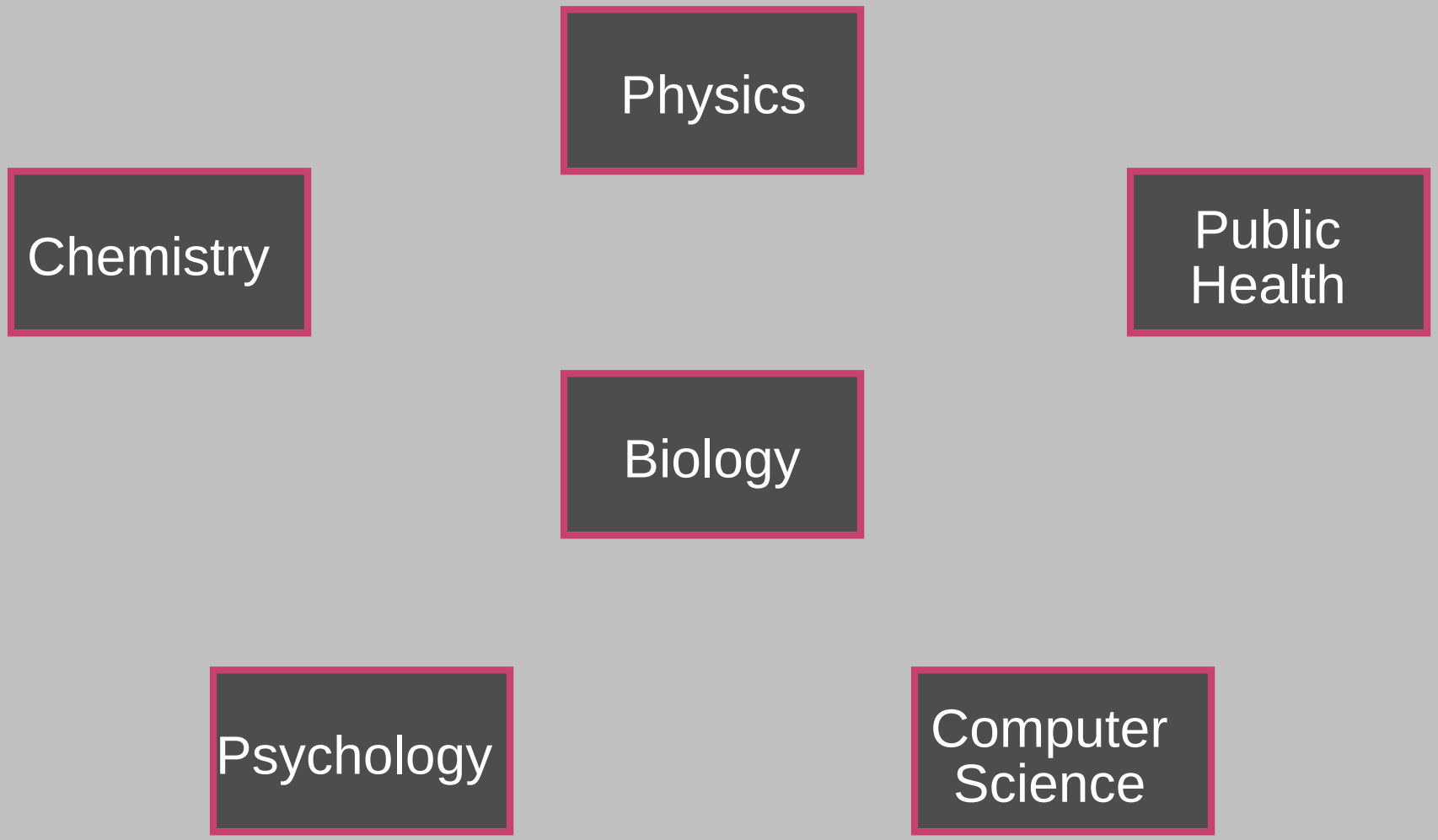
Ranked by number of graduate programs in the top 10 in their field:

1. Berkeley (35)
2. Stanford (31)
3. Harvard (26)
4. Princeton (22)
5. MIT (20)
6. Cornell (19)
7. Yale (19)
8. Chicago (18)

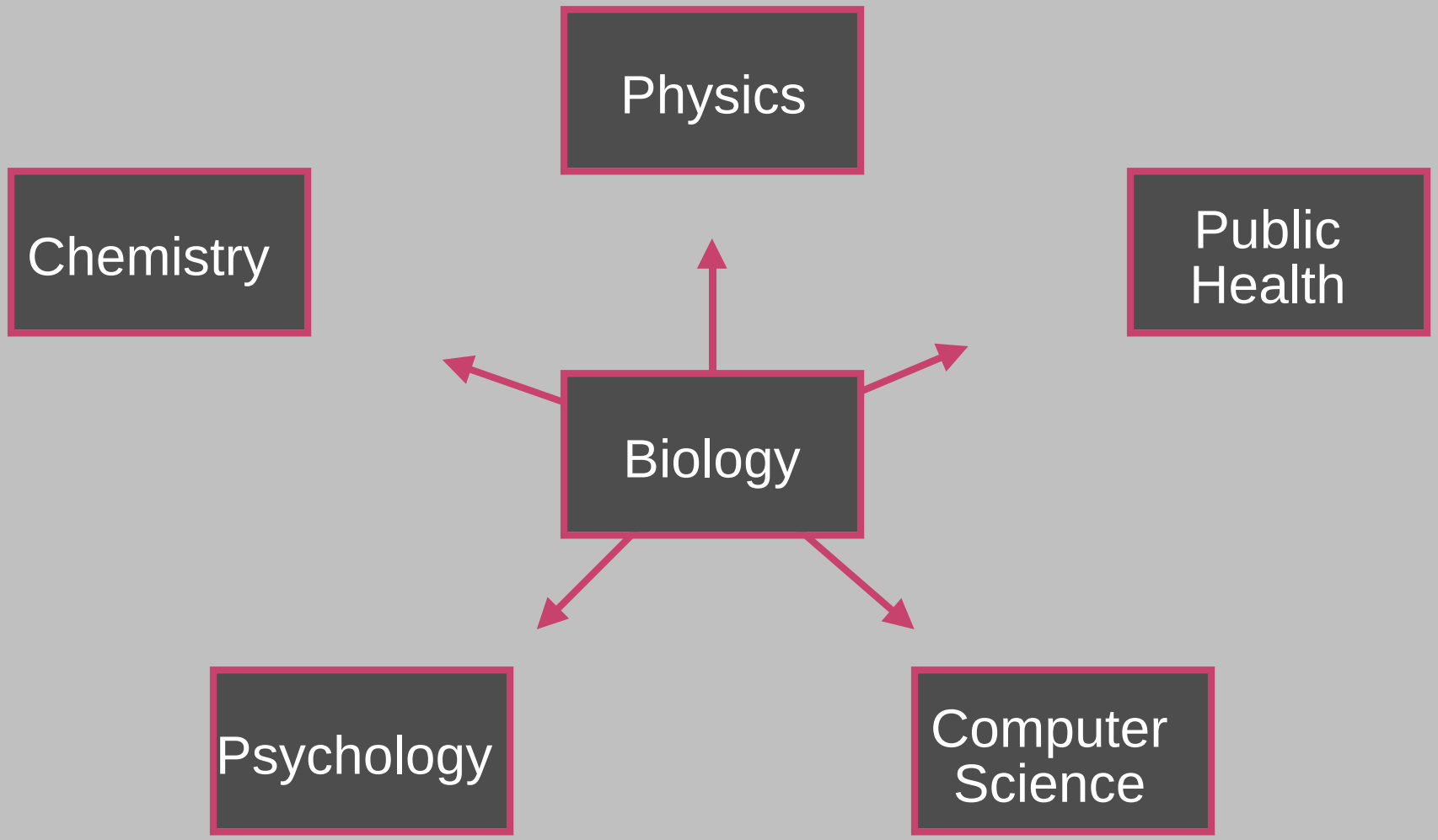
Biological Sciences (all areas combined)

1. Berkeley
2. Stanford
3. Harvard
4. Yale
5. UCSF

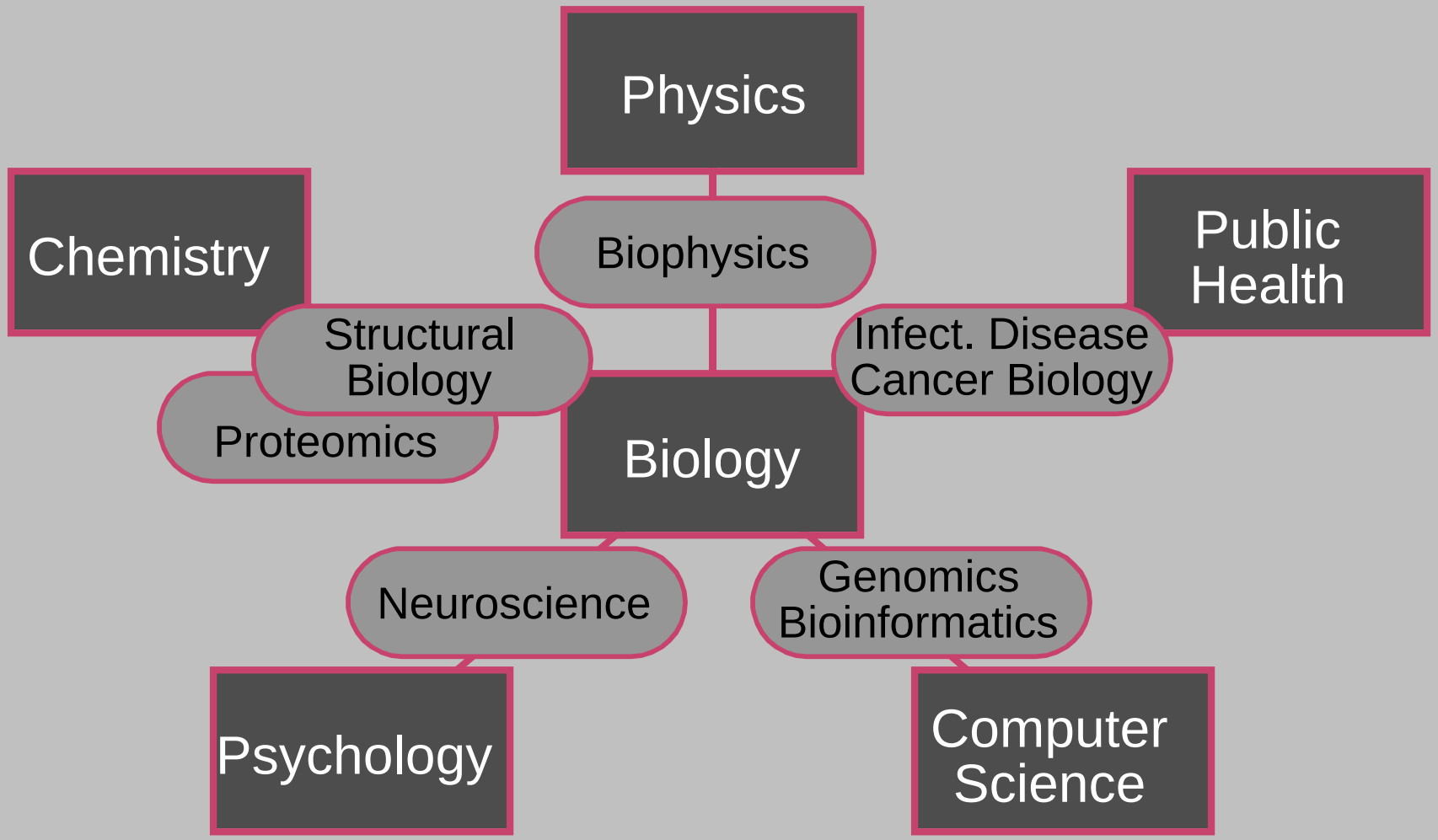
Past Discovery in Biomedical Research: Traditional Disciplines



Future Discovery in Biomedical Research: Building Bridges



Future Discovery in Biomedical Research: The Interface of Traditional Disciplines



Health Sciences at Berkeley:
A New Interdisciplinary Approach

Center for Health Sciences and Bioengineering

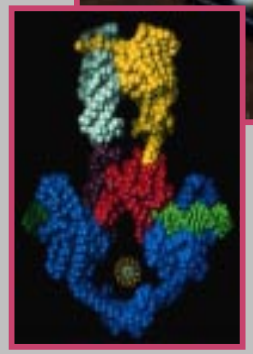
Center for Biomedical and Health Sciences

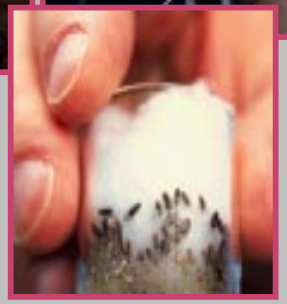
Bioengineering

Physics

Chemistry

Structural Biology





Molecular and Cell Biology

Genomics

Public Health

Cancer Biology

Immunology

Neuroscience

The Health Sciences Initiative at Berkeley: A New Interdisciplinary Approach

Center for Health Sciences and Bioengineering

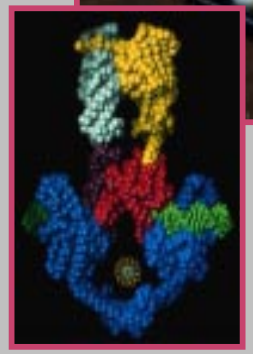
Center for Biomedical and Health Sciences

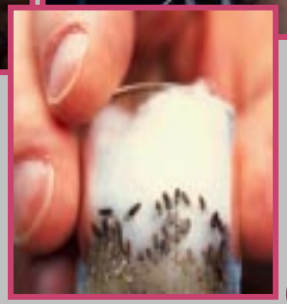
Bioengineering

Physics

Chemistry

Structural Biology





Molecular and Cell Biology

Genomics

Public Health

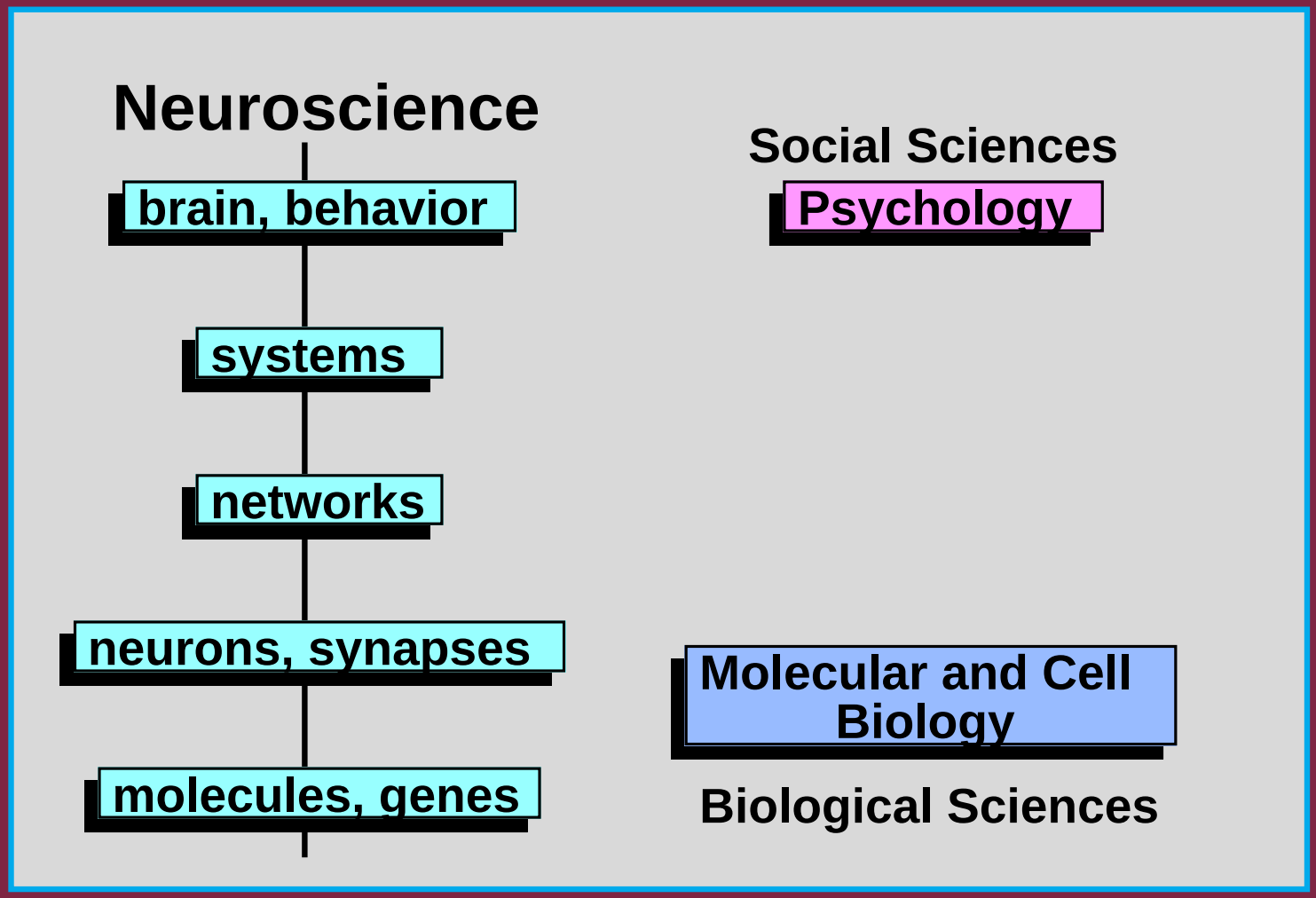
Cancer Biology

Immunology

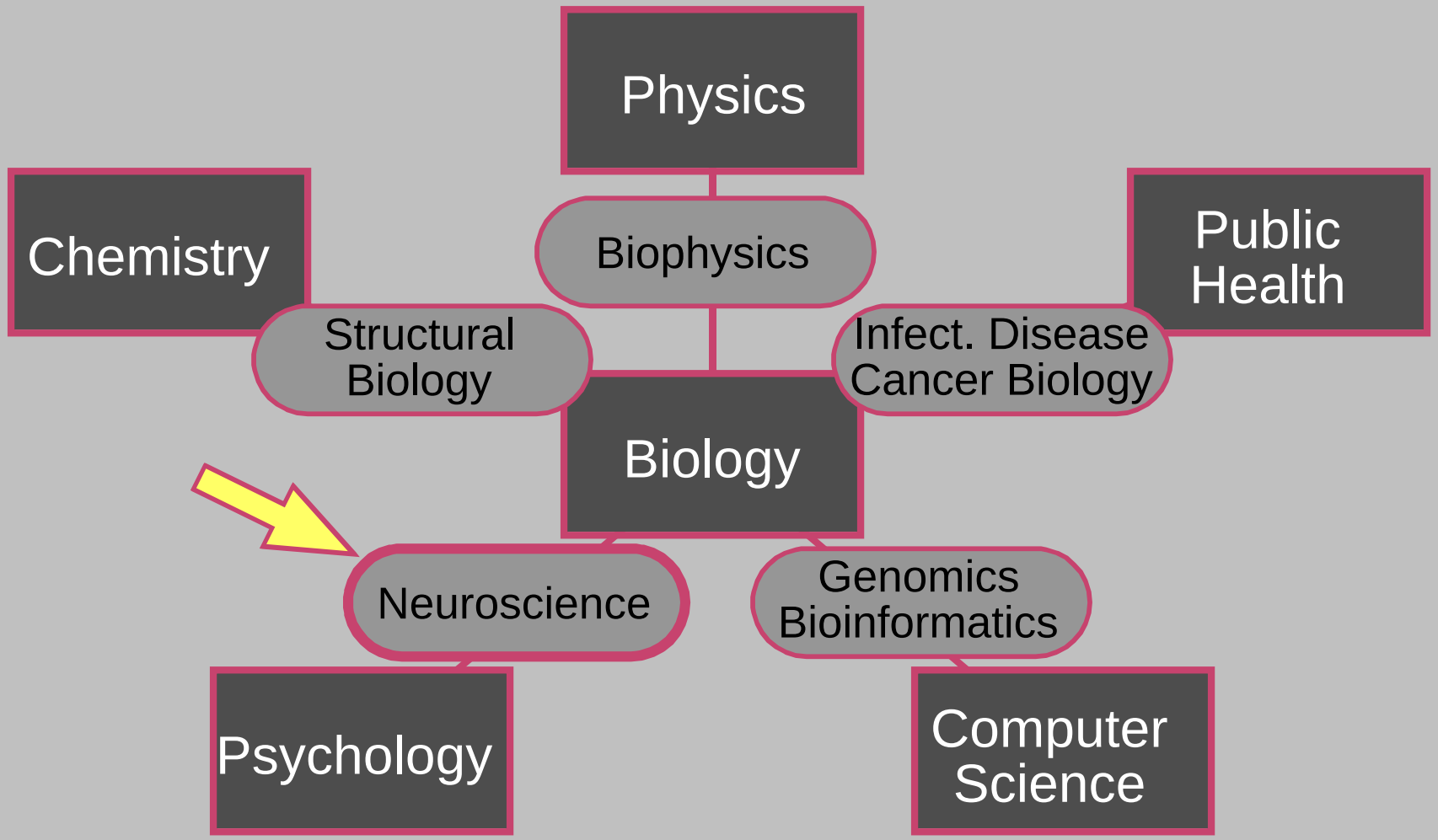
Neuroscience

Understanding The Human Brain and Behavior: The Frontier for Biomedical Research in the 21st Century

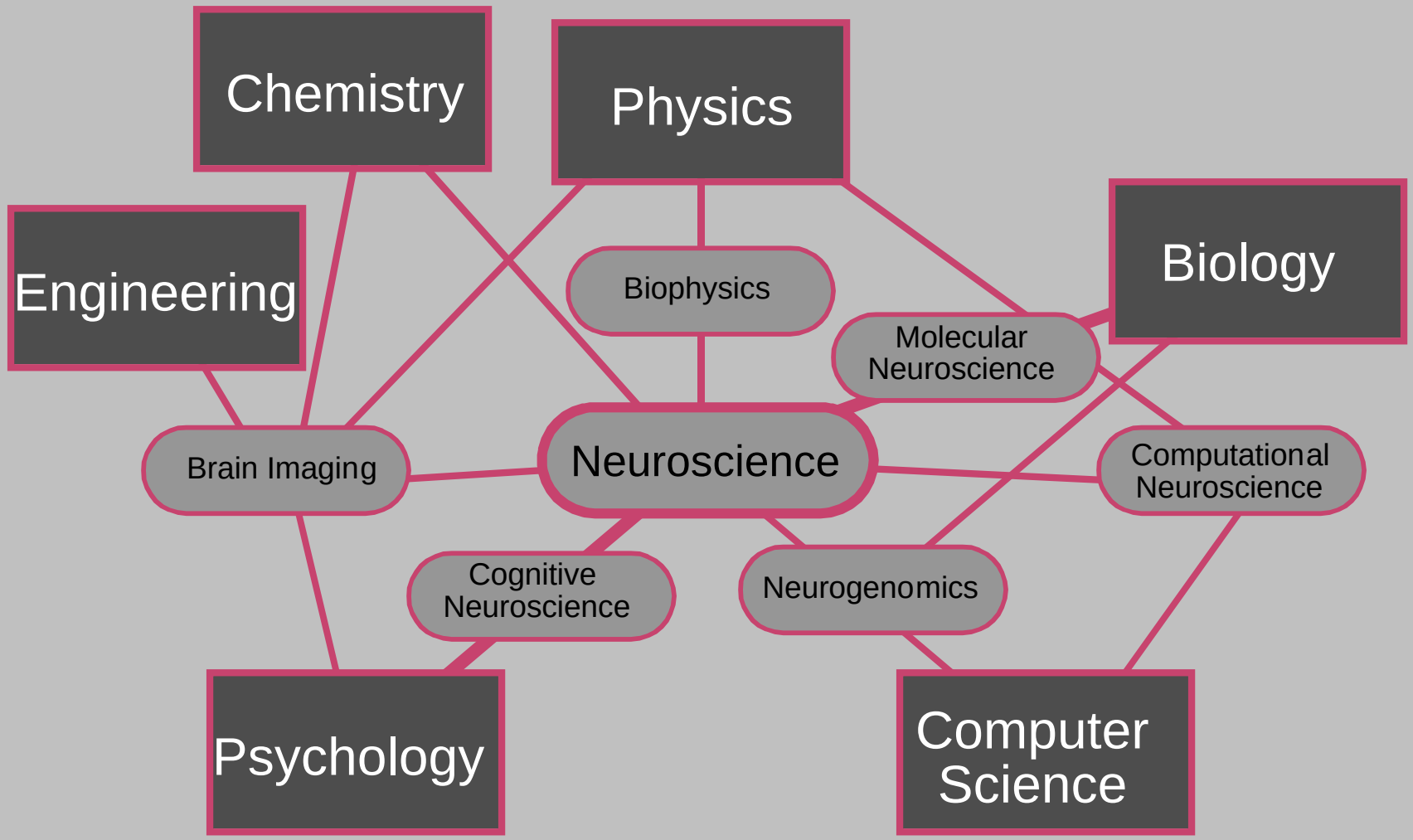
The Traditional Approach: Individual Departments



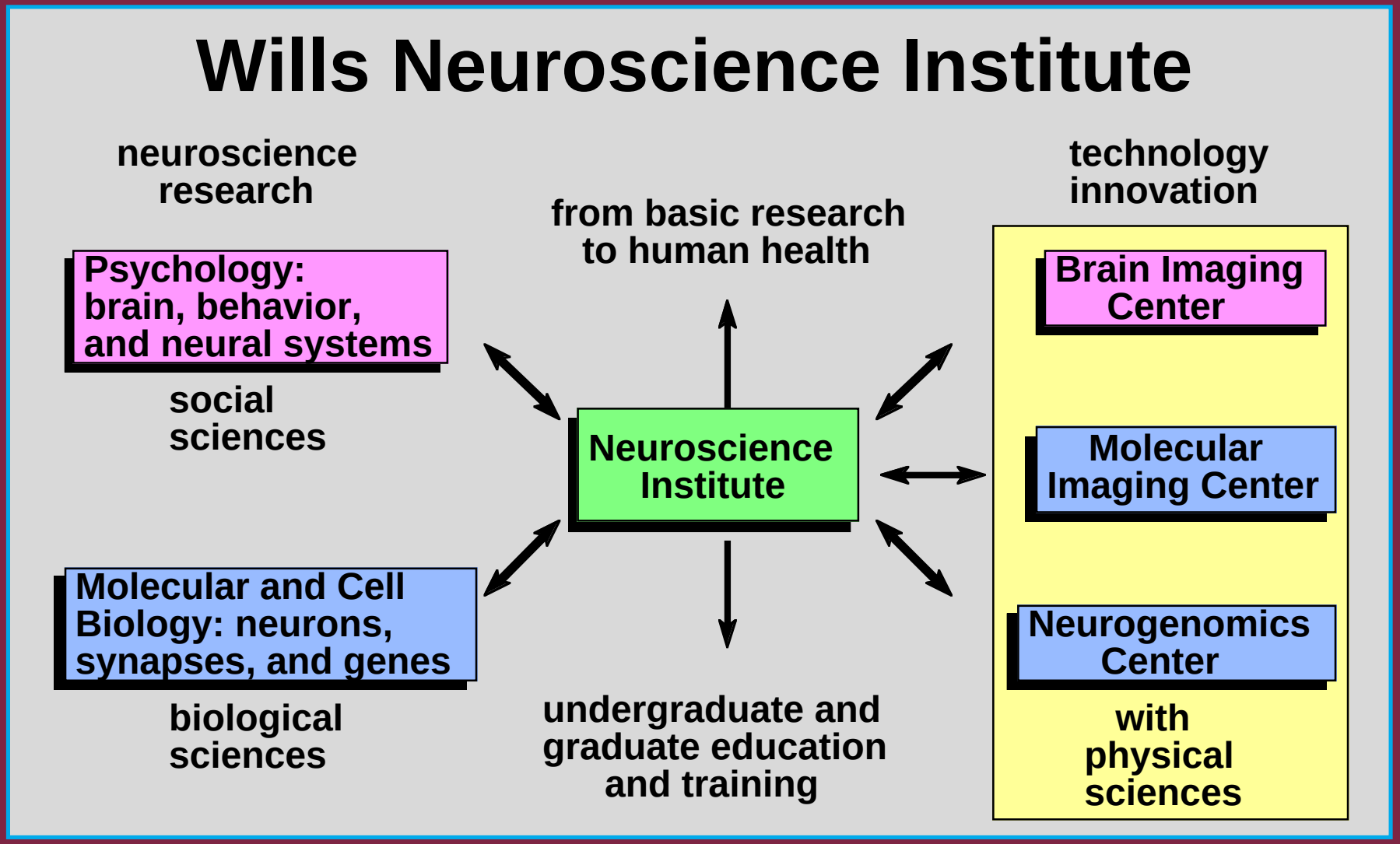
Future Discovery in Biomedical Research: The Interface of Traditional Disciplines



Future Discovery in Biomedical Research: The Interface of Traditional Disciplines



the Berkeley vision: an interdisciplinary approach



vision for the

Wills Neuroscience Institute

(1) **build bridges** across traditional academic boundaries to span from genes to behavior

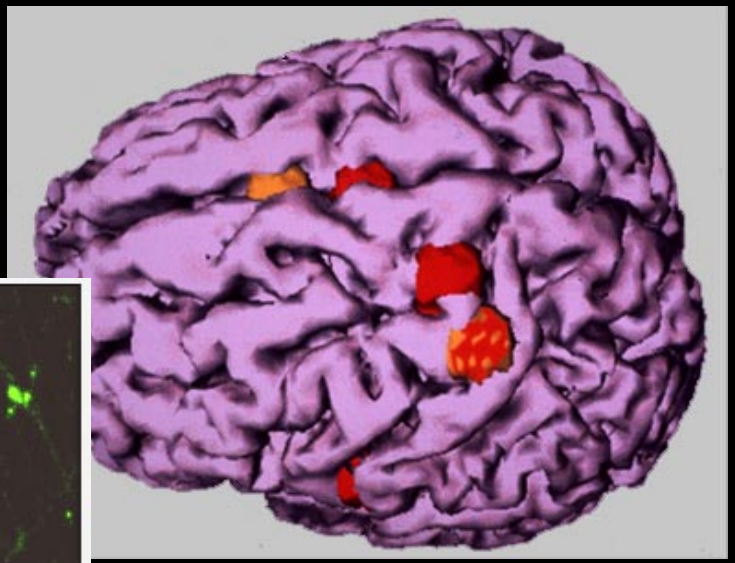
(2) **train graduate students** at this interface to prepare them to become future leaders

(3) **foster collaborations** between biologists and physical scientists for technology innovation

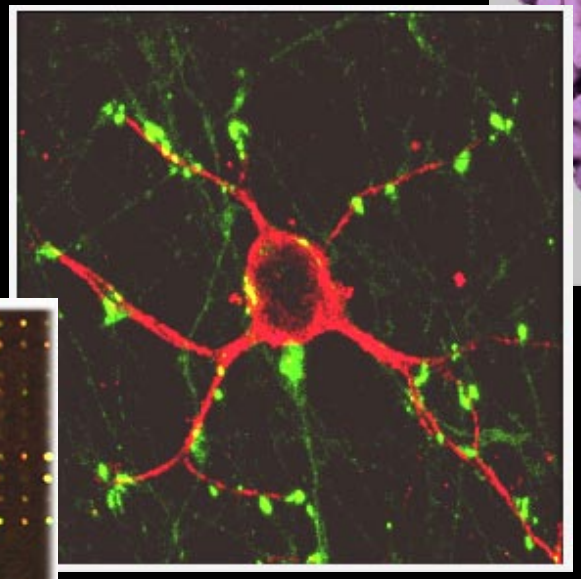
(4) **translate discoveries** in the neurosciences from basic research to human health

Wills Neuroscience Institute

from genes and molecules

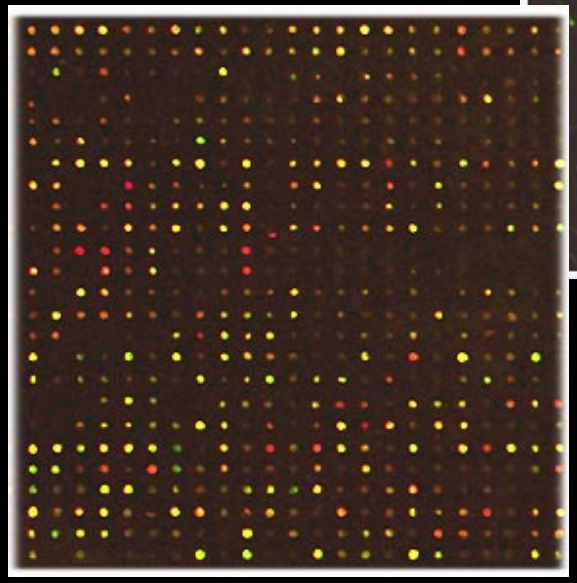


Brain Imaging Center



Molecular Imaging Center

Neurogenomics Center



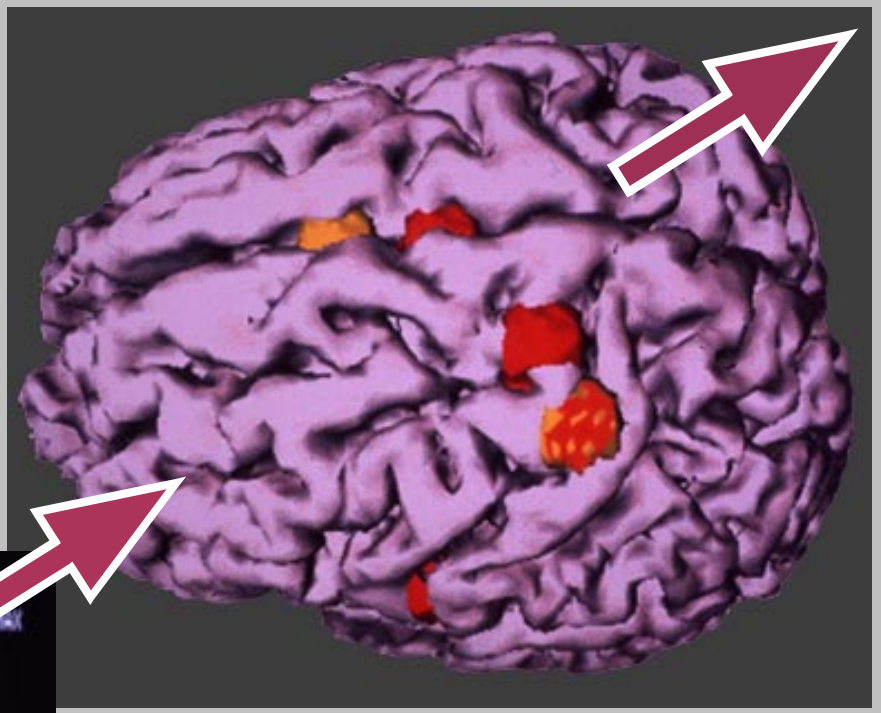
to brain and behavior

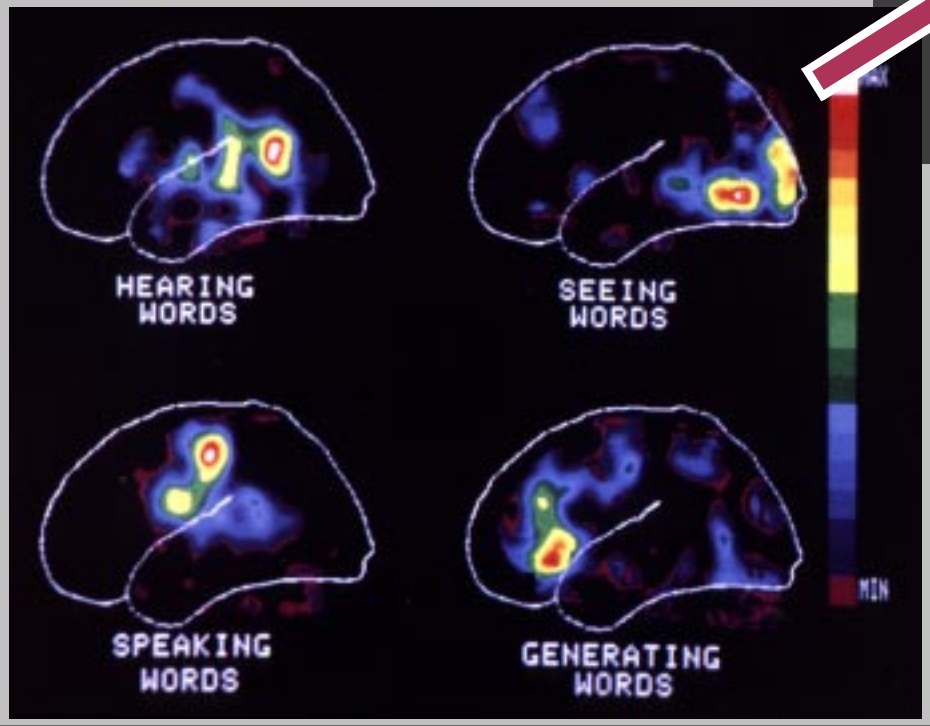
the origins of functional brain imaging: early 1990's

fMRI (Belliveau et al., 1991)
Functional Magnetic Resonance Imaging

PET (Posner and Raichle, 1994)
Positron Emission Tomography

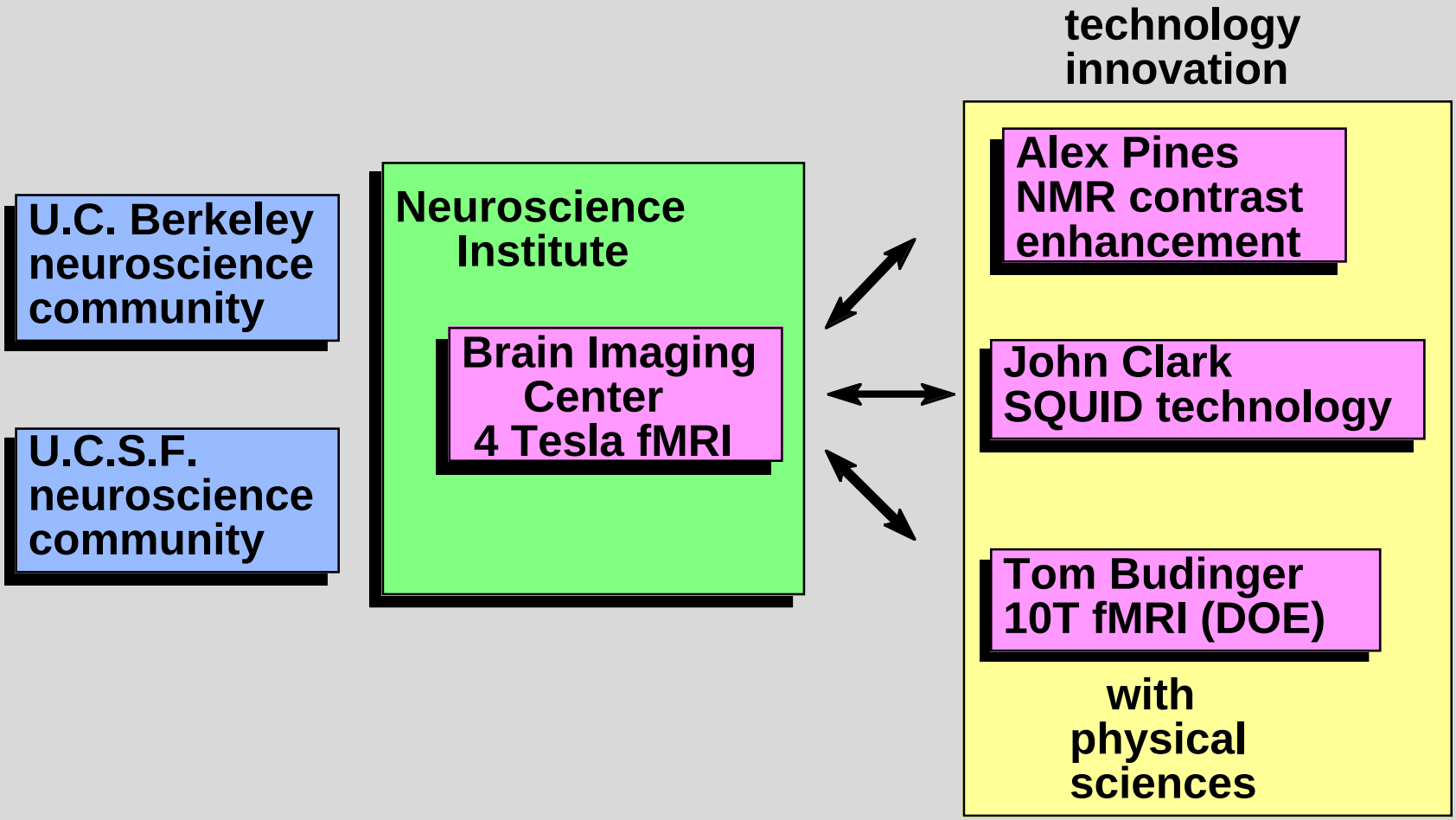
The WNI's Brain Imaging Center



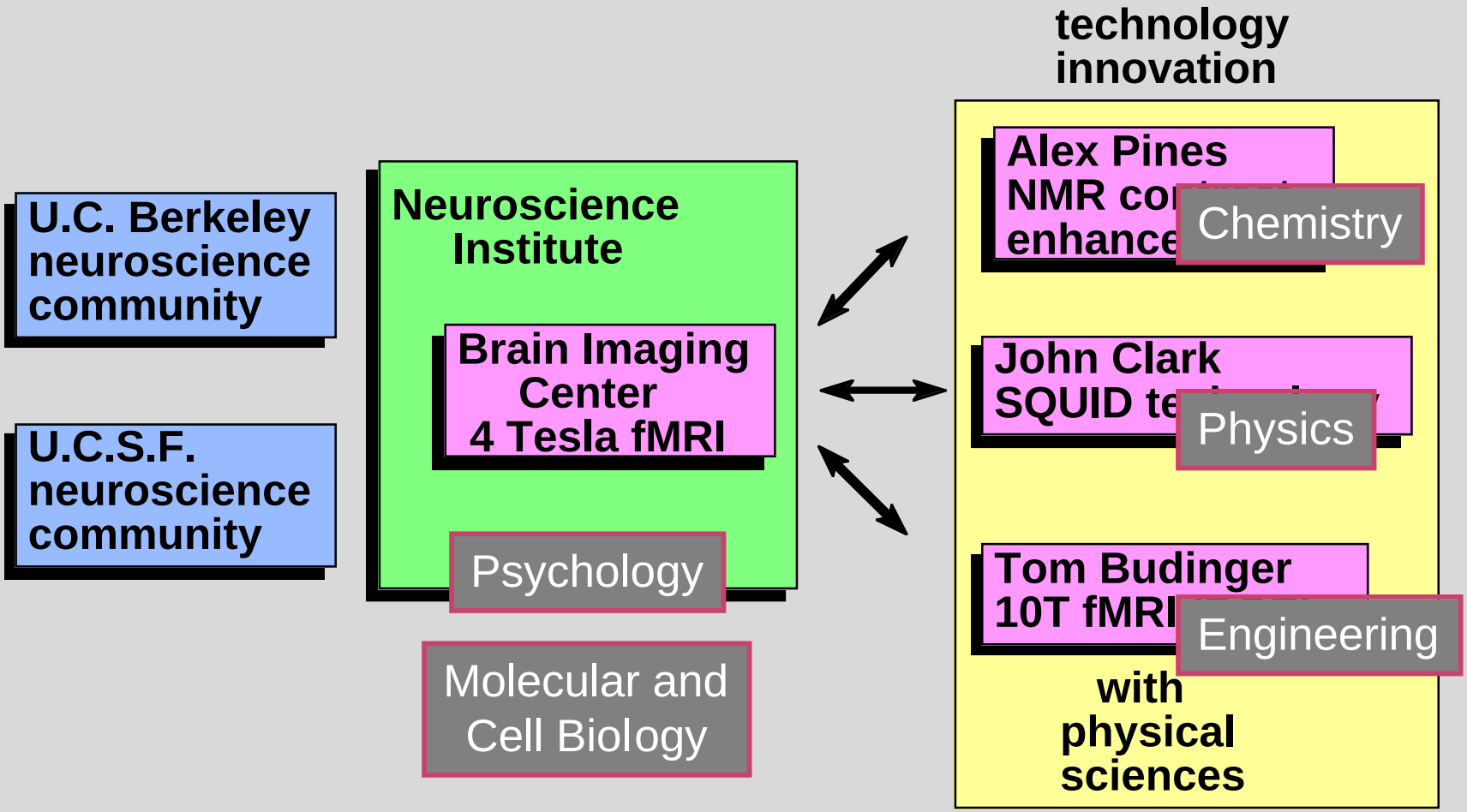


a commitment to advance the technology of functional brain imaging

Wills Neuroscience Institute



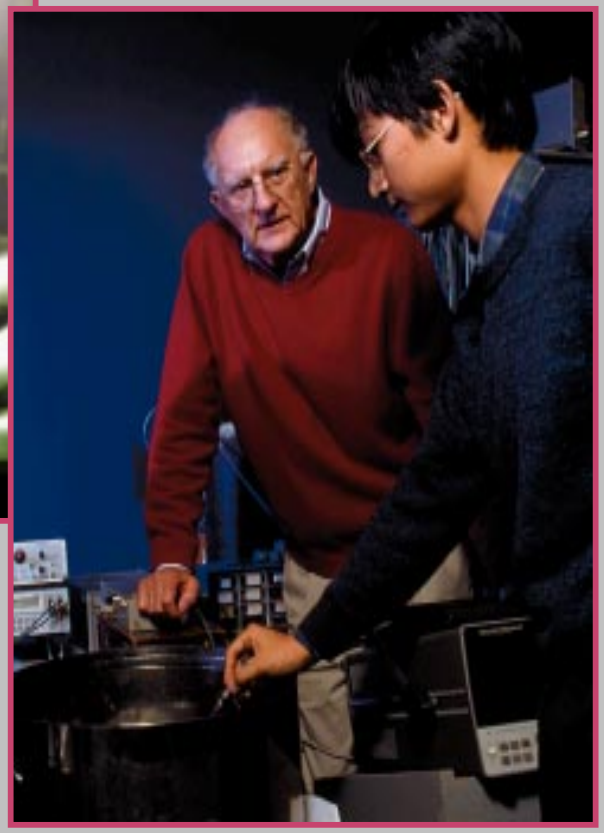
Wills Neuroscience Institute



New Frontiers in Neuroscience:
The Next Generation of Brain Imaging Tools

Alex Pines

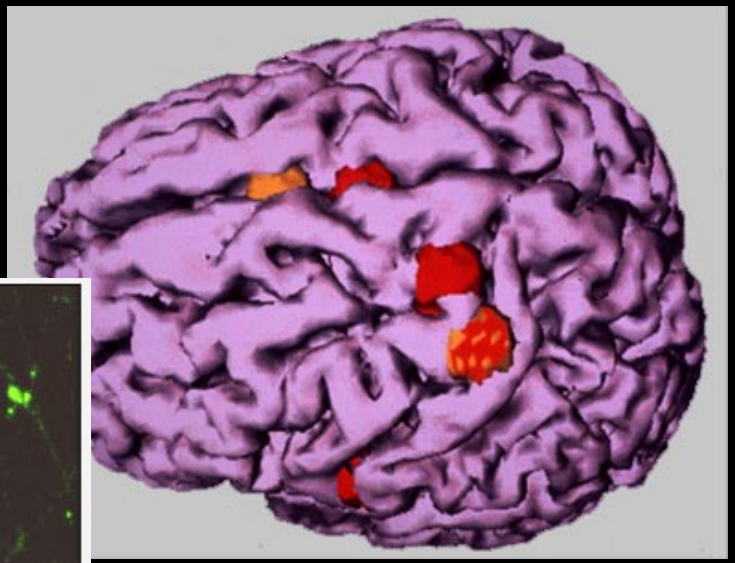
John Clark



Tom Budinger

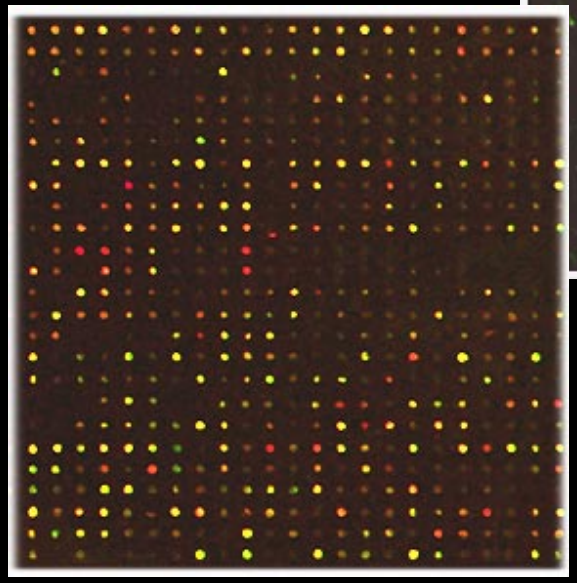
Wills Neuroscience Institute

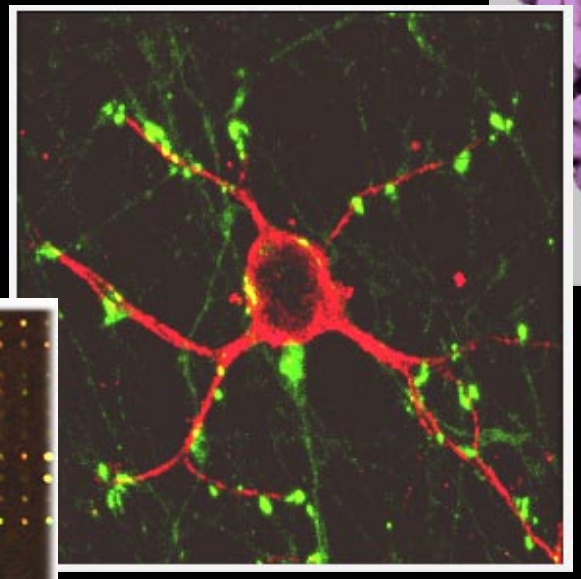
from basic research



brain and behavior

genes and molecules



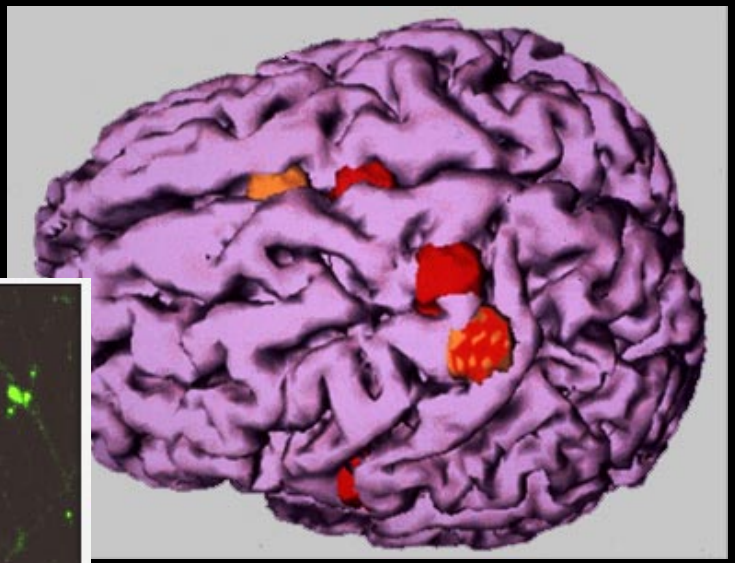


cells and circuits

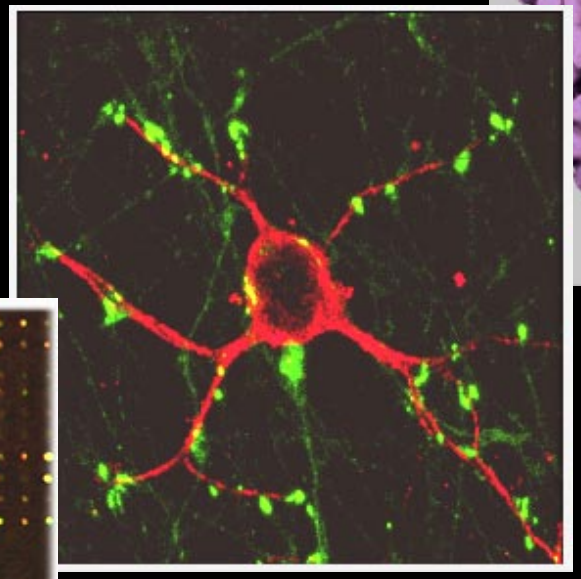
to human health

Wills Neuroscience Institute

identifying the best scientists to take the lead



brain and behavior



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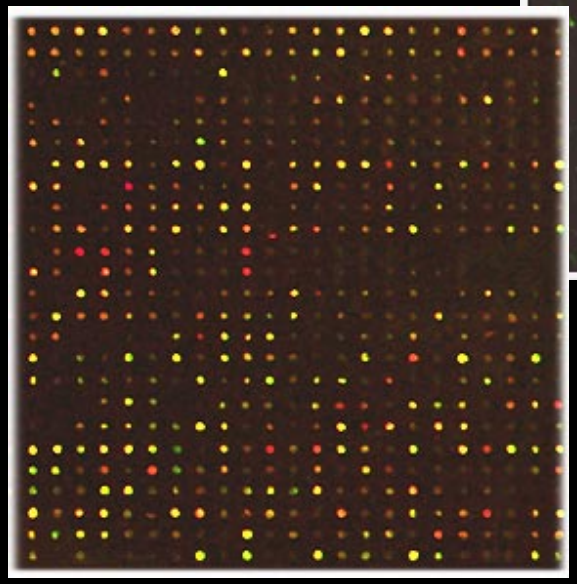
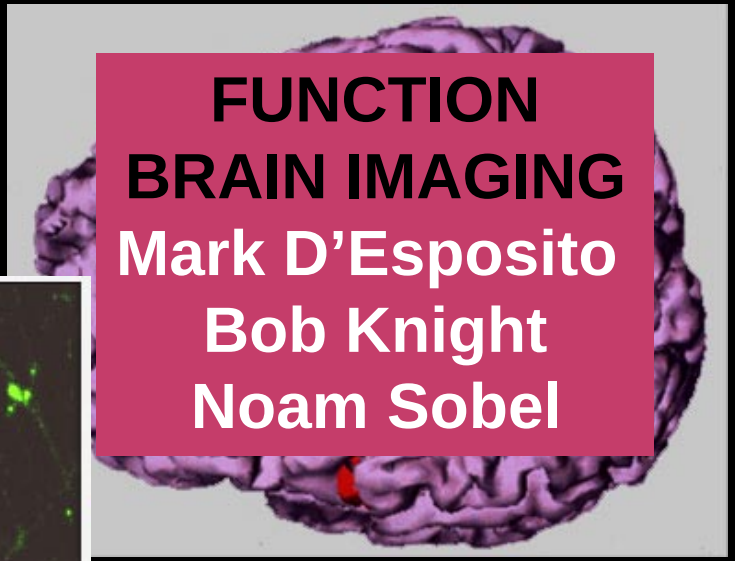


in technology innovation

Wills Neuroscience Institute

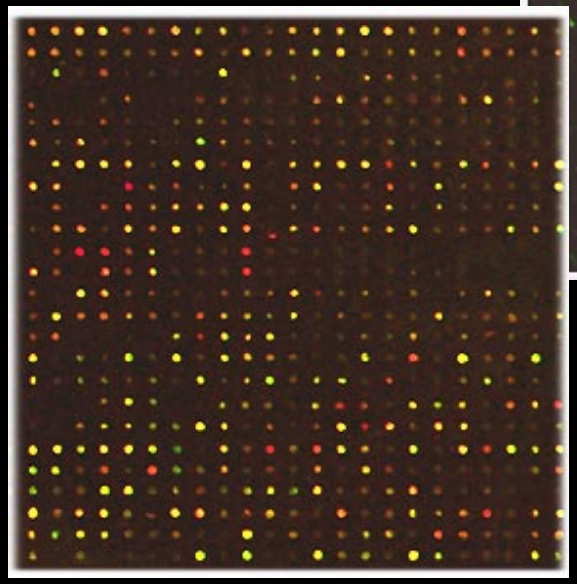
some of our newer faculty who have taken the lead

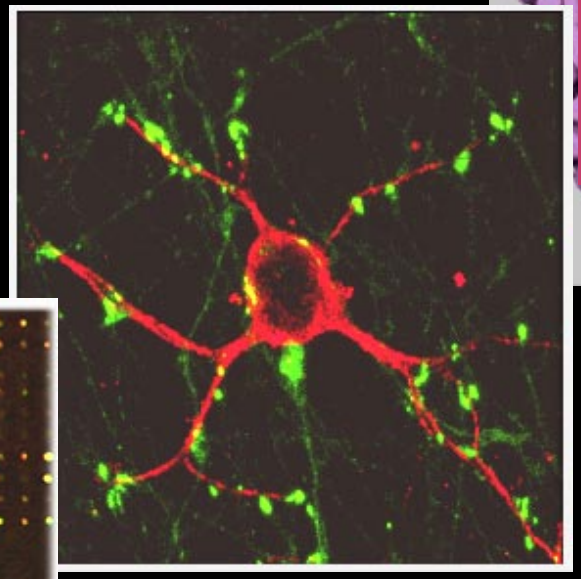


FUNCTION
BRAIN IMAGING
Mark D'Esposito
Bob Knight
Noam Sobel

brain and behavior

genes and molecules





cells and circuits

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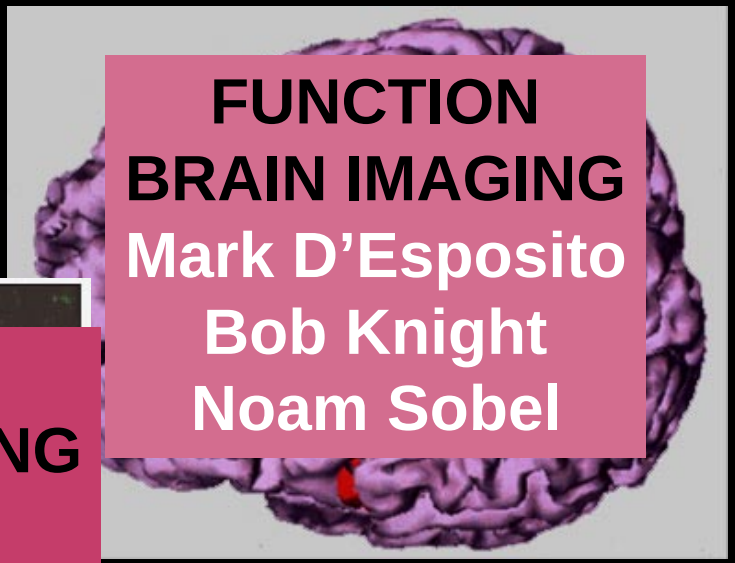
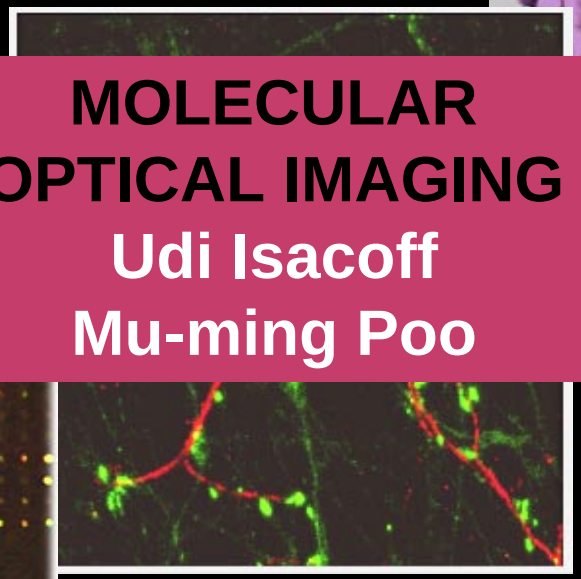
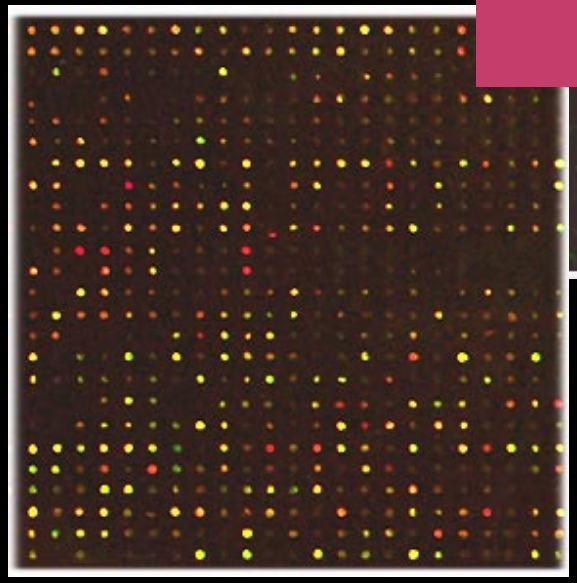


FUNCTION
BRAIN IMAGING
Mark D'Esposito
Bob Knight
Noam Sobel



MOLECULAR
OPTICAL IMAGING
Udi Isacoff
Mu-ming Poo

genes and molecules



cells and circuits

brain and behavior

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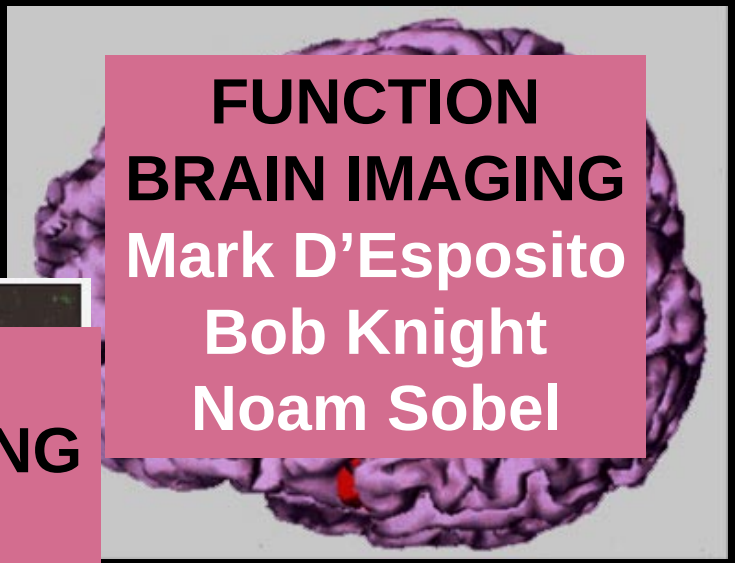
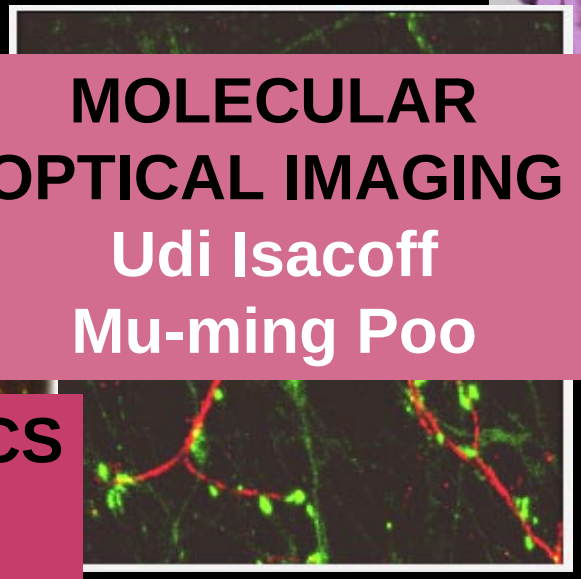


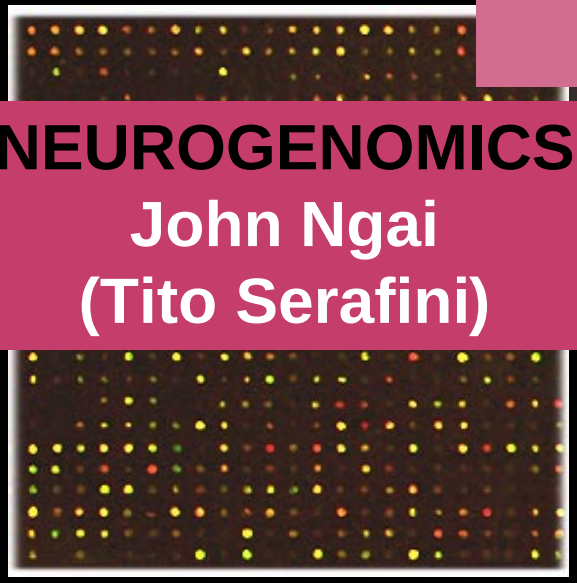
FUNCTION BRAIN IMAGING
Mark D'Esposito
Bob Knight
Noam Sobel

genes and molecules

MOLECULAR OPTICAL IMAGING
Udi Isacoff
Mu-ming Poo



brain and behavior



NEUROGENOMICS
John Ngai
(Tito Serafini)

cells and circuits

in technology innovation

what are the lessons learned ?

(1) the best biomedical research does not need to be attached to a medical school -- rather, connect biology to other sciences

(2) build traditional departments, not but in isolation; the best research buildings in biology will be interactive, built around core technologies

(3) build bridges across traditional disciplines -- the future lies at the interface of biological sciences with other sciences

(4) train graduate students with a grounding in a single discipline, but not in isolation; expose them to the interface with other disciplines

(5) encourage and foster collaborations between biologists and other scientists, including in particular physical scientists, computer scientists, and engineers, for technology innovation

(6) biological research is becoming more outcome minded; support basic research and creativity, but from the outset encourage the rapid translation of discoveries for human health and societal benefit

(7) encourage technology transfer, streamline patents and licenses, build neighboring incubator space, foster entrepreneurial spirit